Original Article

Comparison between C-MAC and King Vision video laryngoscope (channelled blade) for tracheal intubation in aerosol-prevention intubation box for COVID-19 patients: A manikin-based study

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ABSTRACT

Background and Aims: The risk of contracting infection while intubating a coronavirus disease 2019 (COVID-19)-positive patient can be reduced by the use of personal protective equipment (PPE), video laryngoscope (VL) and aerosol-preventing intubation box. We compared two VLs (C-MAC and King Vision laryngoscope [KVL]) for ease of intubation and time taken to intubate the manikin using an intubation box. **Methods:** This randomised study involved healthcare workers having experience in using both C-MAC and KVL. After explaining the study and five practice sessions, a total of 63 volunteers were included; 61 participants gave consent and were enroled. The participants were allowed to intubate initially with one VL as per random sequence. Each participant performed three tracheal intubations with each device (C-MAC VL and KVL) on a manikin using an aerosol-prevention box over the head end at the time of intubation. **Results:** Time taken, percentage of glottic opening (POGO) score and the number of attempts taken for successful intubation with C-MAC and KVL were comparable in any of the three attempts ($P > 0.05$). The participants reported more difficulty in using KVL compared to C-MAC, and insertion of laryngoscope blade into the mouth of manikin for intubation was easy in group C-MAC compared to KVL in all three intubations ($P < 0.01$). **Conclusion:** C-MAC and KVL take comparable time for successful intubation under COVID-19 simulation conditions. But C-MAC is more user-friendly.

Key words: COVID-19, endotracheal intubation, laryngoscope, manikin, personal protective equipment

INTRODUCTION

The outbreak of coronavirus disease 2019 (COVID-19) started at the end of December 2019 in Wuhan, China.[1,2] The clinical presentation of the disease varied from mild illness to severe respiratory illnesses requiring intubation. Tracheal intubation is one of the most aerosol-generating procedures and is thus associated with a high risk of exposure to healthcare workers.[3] The consensus guideline for securing the airway in patients with COVID-19 has recommended donning of appropriate personal protection equipment (PPE), use of video laryngoscope (VL)

for tracheal intubation and aerosol containment using avoidance of bag and mask ventilation, rapid sequence tracheal intubation and use of intubation

box or sheets.[4,5] The C-MAC (Karl Storz, Tuttlingen, Germany) D-blade (non-channelled VL) and King Vision laryngoscope (KVL) (King Systems, Noblesville, IN, USA) (channelled blade) are the two types of commonly used VLs.[6,7] The channelled blade helps in the negotiation of endotracheal tube (ETT) and facilitates easy passage of ETT through the trachea.

The use of a transparent aerosol intubation box or containment box is another good innovation to minimise the spread of aerosol and prevent the splash of direct cough from the patient while intubating. It has been reported to have a beneficial impact by reducing the exposure of aerosol to the physician during the process of tracheal intubation or other airway management procedures. It is placed over the patient's head and neck, and tracheal intubation is done by passing two hands through two circular ports in the box. The obvious benefits of the use of this interface have been reported, but it appears that it also needs training for its appropriate use.

Although the two types of VLs have been evaluated individually in terms of performance and ease of intubation, there is no study in the existing literature comparing these two types of VLs in the COVID-19 scenario. Hence, we prospectively compared the ease of intubation with these types of VLs under the transparent intubation box over the manikin. We hypothesised that intubation with KVL is easy as compared to C-MAC, because the channelled blade in KVL facilitates easy negotiation of ETT into the trachea.

METHODS

This randomised manikin-based study was conducted at a designated COVID-19 treatment facility (tertiary care centre) after obtaining approval from the Institutional Ethics Committee (IEC705/07.08.2020). The clinical trial registration was done before the start of the study (CTRI/2020/10/028637). Medical professionals familiar with C-MAC and KVL and having had performed more than 20 tracheal intubations with each device individually were enroled for the study. The ones who refused consent were excluded [Figure 1].

Every participant was explained the study protocol including the technique of tracheal intubation with two types of VLs and assessment of visualisation of the glottic opening and percentage of glottic

opening (POGO) score seen during laryngoscopy. After this, a video demonstration of the intubation techniques using two VLs with the intubation box was given. Then they were allowed to practice at least five tracheal intubations with each VL along with an intubation box in an airway management trainer (Laerdal Medical Korea, Ltd, Seoul, Korea). Once the practice session was over, the participants, after wearing full PPE (coverall gown, N95 mask, goggles and eye shield), were asked to intubate the trachea of the manikin with the two VLs sequentially [Figure 2]. The choice of use of a particular VL for the initial attempt was as per randomisation and subsequently, another VL was used for tracheal intubation. The computer-generated numbers were concealed in sequentially numbered opaque envelopes. These were opened after the practice session of the participant was over, and the participant was asked to do tracheal intubation as per randomisation for tracheal intubation using either of the VLs on the manikin with intubation box. Aerosol-preventing intubation box (cuboidal box made of transparent fibre glass with the following dimensions: base and top 70 × 40 cm, front face 70 × 50 cm, lateral walls 50 × 40 cm) [Figure 3] with the back covered with transparent polythene was used. Once the participants completed the three sets of tracheal intubations with a particular VL equipment as per randomisation, the other VL was provided. Each participant repeated the sequence thrice to have a total of six intubation attempts (three with each VL). For intubation with KVL, the ETT was preloaded in the tube guide channelled blade and then given by the technician to the participant for intubation. While intubating with C-MAC, the ETT was loaded with stylet and the distal end was bent into hockey shape and given to the participant for intubation. The technician was available throughout the process of intubation for assistance, including the need for optimal external laryngeal manipulation (OELM), removing the stylet, inflating tracheal tube cuff and inflating breathing bag for observing chest rise. An independent observer noted the study findings.

The primary outcome of the study was to compare the time taken for successful tracheal intubation using the two VLs (defined as the time starting from passing the tip of the laryngoscope blade into the mouth of the manikin up to the first chest rise with the resuscitation bag).

The secondary objectives included the following: the number of attempts taken for successful tracheal intubation (maximum of three attempts was allowed,
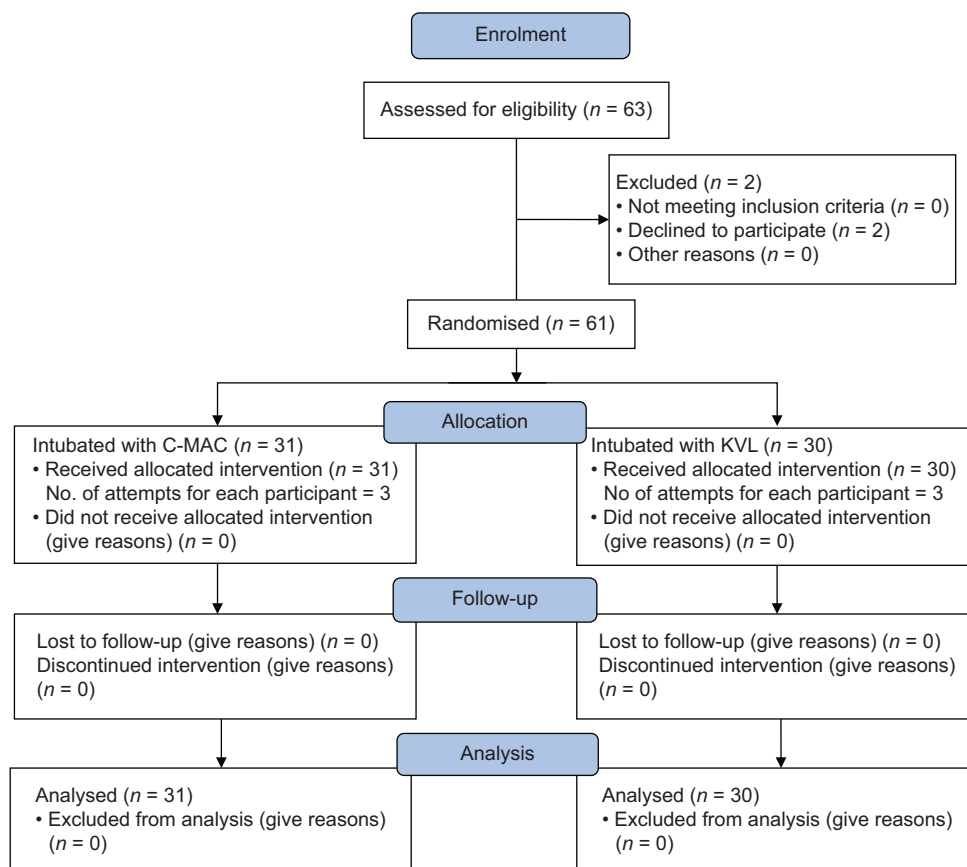
Figure 1: CONSORT flow diagram. CONSORT = Consolidated standards of reporting trials, KVL = King Vision laryngoscope

Figure 2: Intubation of manikin, wearing proper personal protection equipment

and a failed attempt was defined as oesophageal intubation or a time of more than 120 s), percentage of glottic opening (POGO) score, optimisation manoeuvres-readjustment of head position, optimal external laryngeal manipulation (OELM) by the second assistant, severity of dental trauma (number of audible clicks from the manikin's mouth was noted, with each audible click signifying tooth breakage), the reported difficulty level of using the device by the participants (using the scale from 0 [very easy], 1 [easy], 2 [fair], 3 [slightly difficult], 4 [moderately difficult] to 5 [very difficult]) and overall preference of using either of the two VLs (Likert's scale ranging from 0 to 5).

The sample size was estimated based on the results of a similar randomised trial[8] conducted for total time for successful intubation in seconds between KVL (24.9 ± 7.2 s) versus C-MAC (23.3 ± 4.7 s) VL groups with equal size ($r = 1$) of both groups, assuming 95% confidence interval and power of the study (80%). The total sample size calculated was 60, with a minimum sample size required in each group being 30 for statistical inference.

Statistical analysis was performed using Statistical Package for Social Sciences (SPSS) version 24 (SPSS Inc., Chicago IL, USA). Normality of the data distribution was assessed by using the Shapiro–Wilk test, and comparison of success rates was analysed with the help of Chi-squared tests. Analyses of continuous data were performed using Student's *t*-test (unpaired) (for parametric data) and independent-samples Mann–Whitney U test (for non-parametric data) with Bonferroni correction. A *P* value less than 0.05 was taken as significant.

RESULTS

A total of 63 volunteers were selected; 61 participants gave consent and were enroled in the study. Most of them were from the department of onco-anaesthesia, whereas few of them were from Otorhinolaryngology (7%), General Medicine (7%) and Pulmonary Medicine (3%). Most of them were residents and only 25% were faculty. The mean age of the participants (residents of Anaesthesiology, General Medicine, Pulmonary Medicine, General Surgery, Palliative Medicine) was 34.06 ± 4.07 years, with a majority in the 25–35 years age group. The time taken for successful tracheal insertion using C-MAC versus KVL was comparable, and no statistically significant difference was found in all three attempts with each VL ($P > 0.05$) [Table 1]. POGO score with C-MAC and KVL was statistically non-significant in any of the three attempts ($P > 0.05$) [Table 1]. Most of the participants in both groups did not require optimisation manoeuvres in all three intubation
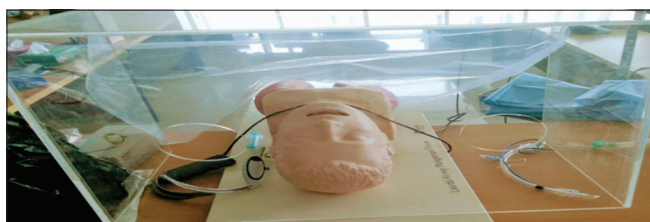
Figure 3: Manikin with transparent aerosol box/intubation box

attempts ($P > 0.05$) [Table 1]. The number of attempts taken for successful intubation at all three times was also comparable ($P > 0.05$) [Table 1]. In the C-MAC group, one dental click was made by a total of six participants in all three intubations and nine participants in the KVL group. Most of the participants in both groups did not make any dental click in any of the two groups and the results were comparable in all three final attempts with no significant difference [Table 1]. The participants reported more difficulty in using KVL compared to C-MAC, as assessed using the scale from 0 (most easy) to 5 (most difficult) ($P < 0.05$ for all three attempts) [Table 1]. Similarly, insertion of laryngoscope blade into the mouth of manikin for intubation was easy in group C-MAC compared to KVL in all three intubations ($P < 0.01$ for all three attempts) [Table 1].

DISCUSSION

We observed from this study that the two VLs (C-MAC and KVL) in manikin simulation for COVID-19 scenario (using PPE and intubation box for aerosol containment) were comparable as assessed by the time taken and the number of attempts for successful tracheal intubation. However, participants were more comfortable with the use of C-MAC compared to KVL.

The process of tracheal intubation is one of the highly aerosol-generating procedures, and it is associated with a great risk of of the intubator getting infected

Table 1: Study parameters in the usage of two devices for tracheal intubation: C-MAC versus KVL				
Study parameters	Attempt number	Group C-MAC (n=31)	Group KVL (n=30)	*P*
Time taken for successful tracheal intubation, s (mean±SD)	A	22.65±6.04	31.97±28.88	0.652
	B	20.35±4.71	26.06±19.43	0.211
	C	19.26±4.90	21.48±8.22	0.562
POGO score (mean±SD)	A	85.48±10.90	88.06±21.51	0.554
	B	86.13±19.77	83.55±26.90	0.631
	C	87.74±21.55	87.74±22.76	0.747
Optimisation manoeuvres (not performed), n (%)	A	25 (80.6%)	25 (83.3%)	0.957
	B	30 (96.8%)	27 (90.0%)	0.285
	C	29 (93.5%)	29 (96.7%)	0.573
Successful tracheal intubation with a single attempt, n (%)	A	31 (100%)	27 (90%)	0.196
	B	27 (87.1%)	28 (93.3%)	0.414
	C	27 (87.1%)	29 (96.7%)	0.173
Dental click (nil), n, (%)	A	28 (90.3%)	25 (80.6%)	0.319
	B	31 (100%)	28 (90.3%)	0.412
	C	27 (87.1%)	29 (93.5%)	0.744
Participant reported difficulty in using the device (mean±SD)	A	1.52±0.76	2.19±1.13	0.011
	B	1.35±0.75	2.03±1.16	0.010
	C	1.42±0.72	2.10±1.10	0.006
Ease of insertion of laryngoscope blade (yes: no), n	A	25 (80.6)	7 (22.6)	<0.001
	B	23 (74.2)	8 (25.8)	<0.001
	C	23 (74.2)	8 (25.8)	<0.001

KVL=King Vision laryngoscope, POGO=percentage of glottic opening, SD=standard deviation

with COVID-19 (about 13 times).[3] So, it is paramount to choose the appropriate type of VL for tracheal intubation of patients for faster and successful intubation with a reduced complication rate. Keeping this in mind, we planned this manikin-based study that compared the two VLs (C-MAC and KVL) for tracheal intubation in a manikin using aerosol-preventing intubation box by a healthcare professional with PPE. The participant was allowed to intubate only after wearing proper PPE and eye-protective goggles to simulate the real situation of intubating a patient of COVID-19, as these hinder the fine movement of the hands and body, as well as eye vision which are required for intubation.[9-14] The use of aerosol-preventing box is also associated with increased time for intubations, as demonstrated by one simulated crossover study by Begley *et al*.[9] Also, in another study, C-MAC video laryngoscopy was associated with easier endotracheal intubation as compared to direct laryngoscopy when used with aerosol-preventing box.[15] The results of our study showed that there is no statistically significant difference in the time taken to successful intubation between the two groups (C-MAC and KVL). Venketeswaran *et al*.[16] studied the intubation outcomes using the aerosol box during the COVID-19 pandemic and observed a non-significant increasing trend in time taken to intubate in patients with higher Mallampati grade with the use of the aerosol box compared to those with low Mallampati score. But they have not compared two different types of laryngoscopes, and also, the study was not done using the manikin. The other parameters like POGO, optimisation manoeuvre, the number of attempts taken for successful intubation and the severity of dental trauma in terms of the number of dental clicks (every click indicates one tooth broken) were also comparable between the C-MAC and KVL groups. However, the KVL was difficult to use compared to C-MAC, as reported by a statistically significant number of participants. Similarly, the ease of insertion of the blade into the mouth of the patient was much higher in the case of C-MAC compared to KVL. Our study is the first of its kind comparing C-MAC versus KVL channelled blade with the use of aerosol-preventing intubation box for intubation in manikin in this pandemic scenario. Another similar study by Gupta *et al*.[17] compared KVL channel blade with Tuoren VL (non-channelled blade) in a simulated COVID-19 scenario using transparent plastic sheet instead of aerosol-preventing intubation box. They observed that KVL had a faster intubation time compared to others. However, in our study, no statistically significant difference in the time taken to intubate was found between the two groups (C-MAC vs. KVL). This may be due to the use of the intubation box, which itself prolongs the time of intubation. Also, another similar study by Vig *et al*.[18] found a similar result when they compared McGrath with C-MAC under similar conditions. The other parameters of our study like POGO view, the number of attempts for successful intubation and use of optimisation manoeuvres were comparable between the two scopes, which is similar to the results of the above-mentioned study.[16]

The majority of the participants found C-MAC easy to use, compared to KVL. This difference can be attributed to the fact that the screen of C-MAC is bigger and away from the working field, which might make it easy to use compared to its counterpart. Another reason could be the blade type of these two VLs, as most of the participants are regularly using the non-channelled blade in clinical practice. Another significant difference found between the two was the ease of insertion of the blade of the laryngoscope during intubation. It was significantly easy in the case of C-MAC compared to KVL. The difference might be attributed to the more curved and thicker tip of the blade in the case of KVL (for the tunnel of the channelled blade), which was difficult to insert easily; in addition, the ETT is already railroaded over the KVL before the insertion of the blade in the mouth, which might limit the working field. Our study had a limitation that crossover of participant groups to alternate (C-MAC and KVL) intubation procedure was not done, which could have further established the study results.

CONCLUSION

C-MAC and KVL have comparable time and number of attempts taken for successful intubation, POGO score, optimisation manoeuvres and dental clicks under COVID-19 simulation conditions. But C-MAC was found to be more user-friendly among the participants, as they found it easy to use and handle.

Conflicts of interest

There are no conflicts of interest.

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